UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

LEVEL II

12

AD A090590

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
14 TOP-2-[illegible]-708	AD-A090 590	

4. TITLE (and Subtitle)

US Army Test and Evaluation Command
Test Operations Procedure
Vehicle Personnel Heater Compatibility

5. TYPE OF REPORT & PERIOD COVERED

Final

6. PERFORMING ORG. REPORT NUMBER

7. AUTHOR(s)

8. CONTRACT OR GRANT NUMBER(s)

9. PERFORMING ORGANIZATION NAME AND ADDRESS

US Army Aberdeen Proving Ground (STEAP-MT-M)
Aberdeen Proving Ground, MD 21005

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS

DARCOM-R 310-6

11. CONTROLLING OFFICE NAME AND ADDRESS

US Army Test and Evaluation Command (DRSTE-AD-M)
Aberdeen Proving Ground, MD 21005

12. REPORT DATE

18 July 1980

13. NUMBER OF PAGES

9

14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)

15. SECURITY CLASS. (of this report)

Unclassified

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

OCT 20 1980

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Vehicle personnel heaters
Vehicle defroster systems
Heater endurance

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Describes procedures for evaluating the performance of personnel heater systems when installed in a vehicle. Procedures do not pertain to engine heaters or the establishment of heater operating characteristics.

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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US ARMY TEST AND EVALUATION COMMAND
TEST OPERATIONS PROCEDURE

DRSTE-RP-702-101
*Test Operations Procedure 2-2-708 18 July 1980
AD No.

VEHICLE PERSONNEL HEATER COMPATIBILITY

1. SCOPE. This TOP provides procedures for evaluating the performance of personnel heater and defroster systems when installed in a vehicle. The assumption is made that heater operating characteristics have already been established by the developing agency or separate tests in accordance with TOP 10-2-072. Tests are usually conducted in conjunction with vehicle low temperature tests (TOP 2-2-816). These procedures do not pertain to engine heaters which are tested in conjunction with the cold starting tests of TOP 2-2-650.

2. FACILITIES AND INSTRUMENTATION.

2.1 Facilities.

2.1.1 For Chamber Climatic Tests. A temperature chamber for conditioning the vehicle at temperatures down to -51°C (-60°F).

2.1.2 For Outdoor Climatic Tests.

a. A subarctic environmental test site where natural environmental conditions can be expected to produce air temperatures to -51°C.

b. Test courses, including improved, unimproved, and secondary roads as well as cross-country courses capable of supporting the full range of vehicle operations.

c. A heated enclosure for preparing the vehicle for test.

*This TOP supersedes MTP 2-2-708, 19 January 1966.

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2.2 Instrumentation.

ITEM	MAXIMUM ERROR OF MEASUREMENT*
Temperature sensors and recorder	-51° C to +149° C ±1.4° C (-60° F to +300° F ±2.5° F)
Toxic-fume measuring equipment	As described in TOP 2-2-614
Meteorological equipment:	
Thermograph	Temperature to ±0.4° C
Hygrothermograph	Relative humidity to ±1%
Anemograph	Wind speed to ±1.5 knots

*Values may be assumed to represent ±2 standard deviations; thus the stated tolerances should not be exceeded in more than 1 measurement out of 20.

3. PREPARATION FOR TEST.

3.1 Planning.

a. Prepare a test operations checklist using the appendix as a guide and adding specifics for the test item and situation.

b. Design a data collection sheet to record such information as indicated in paragraphs 3.5, 5.1.2, 5.2.2, and 5.3.2.

3.2 Vehicle.

a. Obtain a vehicle of the type in which the test heater is to be used.

b. Prepare the vehicle for cold weather operation in accordance with the vehicle technical manual and FM 9-207 1/ (e.g., arctic antifreeze installed in cooling system and arctic lubricating and gear oils installed in other systems as prescribed in the lubrication order for cold weather operation).

c. Inspect windows, doors, and hatches for proper sealing.

d. Prepare for defroster evaluation by one of the following means:

(1) Divide the windshield into equal squares with sides no greater than 25 cm (10 in.) using straight line marks of soap or grease pencil.

1/ FM 9-207, Operation and Maintenance of Ordnance Materiel in Cold Weather (0° to -65° F).

(2) Install a camera with a wide angle lens in the crew compartment to photograph the windshield. When appropriate, provide for remote operation.

3.3 Heaters.

a. Inspect the heater and other winterization kit components for equipment discrepancies, damage, or missing parts. If damages have been sustained, obtain authorization and make repairs where possible.

b. Install the heater and other kit components on the vehicle in accordance with the instructions provided with the kit.

3.4 Instrumentation.

a. Install temperature sensing devices (thermocouples, etc.) at heater and defroster outlets; at the level of feet, hands, and head in personnel compartments; and, when applicable, at specified locations in cargo or van compartments. Use a sufficient number of temperature sensors to obtain a balanced pattern of measurements for determining both average compartment temperature distribution and location of hot and cold spots. In the vehicle crew compartment these measurements include temperature recordings from positions within 6 inches of compartment walls on the driver's side, the middle and the passenger's side.

b. For tests of fuel-burning heaters, install instrumentation to measure toxic fume levels as described in TOP 2-2-614.

3.5 Data Requirements. Record the following:

a. Vehicle: Nomenclature; engine description; type and grade of fuel, lubricants, and other POL; personnel capacities.

b. Personnel Heater: Type; manufacturer; serial number; technical description to include heating capacity (Btu), external power requirement, fuel consumption, method of operation (i.e., direct fired air or hot water heat source).

c. Instrumentation: Nomenclature; range and accuracy; calibration date; application and location.

4. TEST CONTROLS.

a. Observe guidelines of pamphlet by US Army Environmental Hygiene Agency 2/.

b. Throughout testing, perform preventive (scheduled) maintenance as prescribed in the applicable technical manual; perform corrective (unscheduled) maintenance as required to keep the test heater and vehicle operational.

c. Restrict outdoor heater tests on a stationary vehicle to times when incident wind velocities are below 10 mph.

2/ US Army Environmental Hygiene Agency. Technical Guide (Med) TG-003, Protection of Personnel in Hot and Cold Climatic Chambers.

d. Do not conduct tests when there is a rapid variation in ambient air temperature. If the ambient air temperature varies more than 5.6°C (10°F) during a test, repeat the test.

e. Check for concentrations of carbon monoxide (CO) in crew compartments before manning the vehicle. If the CO level exceeds 50 ppm, terminate testing until the cause can be investigated and corrected.

f. Rotate personnel selected to give subjective evaluations of heater performance as often as possible.

5. PERFORMANCE TESTS.

5.1. Chamber Climatic Test.

5.1.1 Method.

a. Place the vehicle with the test heater in a suitable climatic chamber.

b. Install ducts to remove the exhaust of fuel-burning heaters or the exhaust of the vehicle when the heater uses the vehicle engine as the heat source.

c. Unless otherwise specified, reduce the chamber temperature to -51°C (-60°F) to meet the severe cold condition of AR 70-38, and allow the vehicle and test heater to stabilize to the temperature. Stabilization is considered reached when the temperature of the vehicle crew compartment does not vary more than 2°C (3.5°F) per hour. Test temperature is more rapidly attained by opening vehicle windows, doors, and hatches during the cold soak period. If the ambient air temperature varies more than 5.6°C (10°F) during the stationary vehicle test (5.2.1.1), or the moving vehicle test (5.2.1.2), then repeat the test. Testing should not be conducted when there is a rapid variation in ambient air temperature.

d. If the heater uses the vehicle engine coolant as the heat source, start the vehicle and allow the engine to reach normal operating temperature.

e. Close all windows, doors, and hatches.

f. For vehicles having defroster systems, spray the outside of the windshield with water until approximately 1/32-inch of ice is formed.

g. Start the personnel heater and activate the defroster system. Operate the heater at maximum output for a minimum of 1 hour (4 hours for shop and instrument vans) or until the temperature of the observed vehicle compartment stabilizes. Sketch or photograph the defrosted area of the windshield and record air temperatures and toxic-fume levels within the vehicle compartment at five-minute intervals starting with heater turn-on.

5.1.2 Data Required.

a. Before heater operating:

(1) Chamber test temperature.

(2) Vehicle and test heater soak time.

(3) Vehicle compartment temperature.

b. During heater operation:

(1) Personnel compartment temperatures at level of feet, hands, and head.

(2) Cargo compartment or van temperatures at specified locations.

(3) Heater inlet and outlet, and defroster outlet, temperatures.

(4) Toxic-fume levels (CO, NO_2, etc.) as described in TOP 2-2-614.

(5) Sketches or photographs of the windshield annotated with time of exposure and percent of windshield defrosted.

(6) Time required for compartment temperatures to stabilize and stabilization temperature.

(7) Maintenance requirements.

(8) Identification of hot components which are a potential burn hazard.

5.2 Outdoor Climatic Test.

5.2.1 Method.

a. Select test site as described in paragraph 2.1.2. Test should be repeated for as many discrete average ambient temperatures as possible ranging from -34° to -51° C (-30° to -60° F) to determine the ambient temperature at which the crew compartment can be maintained at 4.4° C (40° F) or, when applicable, a patient compartment at 10° C (50° F).

b. Cold soak the vehicle until personnel compartment air and surface temperatures stabilize to within 2.8° C (5° F) of the ambient temperature. Test temperature is more rapidly attained by opening the vehicle windows, doors, and hatches during the cold soak period.

c. Place the maximum number of personnel authorized in the crew compartment to ensure a moisture source for maximum frost formation.

d. If the heater utilizes the vehicle engine coolant as the heat source, start the vehicle and allow the engine to reach normal operating temperature.

5.2.1.1 Stationary Vehicle. Start the personnel heater and activate the defroster system. Operate the heater at maximum output for a minimum of 1 hour (4 hours for shop and instrument vans) or until the temperature of the observed vehicle compartment stabilizes. Photograph the inside of the windshield at 1-minute intervals for the first 15 minutes of the test and at 5-minute intervals thereafter until the windshield becomes 75 percent defrosted or no further clearing is observed. Record air temperatures and toxic-fume levels within the vehicle compartment and ambient outside air temperature at 5-minute intervals starting with heater turned on.

5.2.1.2 Moving Vehicle.

a. If sufficient heating and defrosting for safe vehicle operation is demonstrated during the stationary vehicle test (para 5.2.1.1), prepare the vehicle and test equipment for mobile operation. Insure that no more than the authorized number of personnel occupy the vehicle.

b. With the vehicle traveling at 15 to 25 mph over improved roads, operate the heater at maximum output for one hour or until compartment temperatures stabilize. Record compartment air temperatures at 5-minute intervals, monitor outside ambient air temperature continuously, and photograph windshield defrosting conditions at 5-minute intervals.

5.2.2 Data Required.

a. Before heater operation:

(1) Ambient outside air temperature.

(2) Vehicle and test heater soak time.

(3) Vehicle compartment temperature.

b. During heater operation:

(1) Ambient outside air temperature.

(2) Personnel compartment temperatures at level of feet, hands, and head.

(3) Cargo compartment or van temperatures at specified locations.

(4) Heater inlet and outlet temperatures.

(5) Defroster outlet temperature.

(6) Photographs of the windshield annotated with time of exposure and percent of windshield defrosted.

(7) Time required for compartment temperatures to stabilize and stabilization temperature.

(8) Maintenance requirements.

(9) Toxic-fume levels (CO, NO_2, etc.) as described in TOP 2-2-614.

5.3 Heater Endurance.

5.3.1 Method. Select test site as described in paragraph 2.1.2. Unless otherwise specified, operate the heater system for a minimum of 250 hours with the vehicle traveling over unimproved and secondary roads in temperatures varying from 0° to -51° C (32° to -60° F). For fuel-burning heaters, accumulate heater operating time by alternately running the heater for 24 hours at high and low settings and cycling 20 minutes on and 10 minutes off. Count only heater "on" time as operating time. Use military personnel to accumulate a portion of the heater operating time as established on a test-to-test basis during test planning.

5.3.2 Data Required.

a. Heater operating time.

b. Ambient temperature.

c. Maintenance requirements.

6. DATA REDUCTION AND PRESENTATION.

a. Tabulate all data collected and compare the data with test criteria. Report all discrepancies by Equipment Performance Report (EPR).

b. Prepare time versus temperature curves for measured locations within the vehicle compartment.

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APPENDIX
CHECKLIST GUIDE FOR VEHICLE PERSONNEL HEATER COMPATIBILITY TESTS

ITEM	YES	NO	NA
1. Vehicle prepared for cold weather operation.			
2. Crew compartment checked for toxic fumes.			
3. Wind velocities below 10 mph.			
4. Ambient air temperature variance within required limits.			
5. All required instrumentation calibrated, properly installed, and operational.			
6. Required data recorded.			
7. Safety procedures posted and followed.			